

هندسة الميكانيك العام السنة الأولى

فريق الكريات الحمراء

# الحركة

...الجزء الرابع ...

حل مسائل البحث الرابع ✓  
ملاحظات حول كيفية الحل ✓



pages  
sp



# مسألة 1

المعطيات:

$$n = 1500 \text{ (r.p.m)} = \frac{1500}{60} = 25$$

$$\omega = 2\pi n = 50\pi = 157 \text{ rad/s}$$

$$OB = r = 12.5 \text{ cm}, l = 25 \text{ cm}, GB = 10 \text{ cm}, \theta = 60^\circ$$

حساب الزاوية  $\alpha$  باستخدام الشكل

$$AB = OB \Rightarrow 25 = 12.5 \Rightarrow \alpha = 26^\circ \Rightarrow \phi = 90 - \alpha = 64^\circ$$

$$\sin \theta \quad \sin \alpha \quad \sin \phi \quad \sin \alpha$$

الزاوية  $\theta$  دورانية

$$v_B = \omega_{OB} \cdot OB = 157 \times 0.125 = 19.63 \text{ m/s}$$

AB متحركة المقرب من B

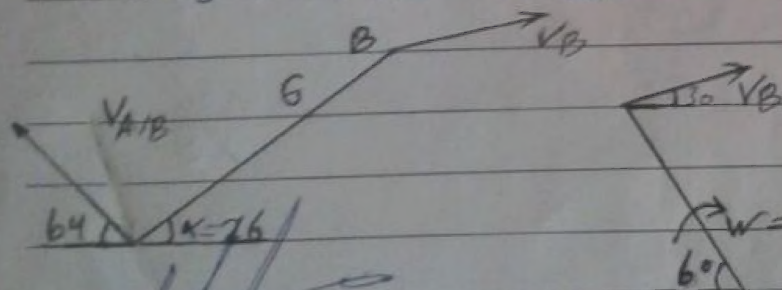
$$v_A = v_B + v_{A/B}$$

$$\alpha: v_A = v_B \cos 30 = v_{A/B} \cos 64 \Rightarrow v_A = 20.8 \text{ m/s}$$

$$\beta: 0 = v_B \sin 30 + v_{A/B} \sin 64 \Rightarrow v_{B/A} = -v_B \sin 30 = -10.9 \text{ m/s}$$

$$\sin 64$$

على الاتجاه المعروض

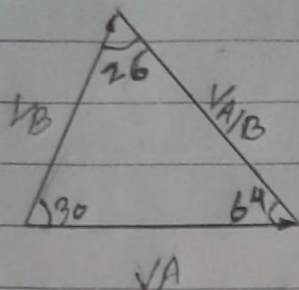


$$\omega = 157 \text{ rad/s}$$

$$60^\circ$$

الطريقة الثانية: السرعة





$$\frac{v_{A/B}}{\sin 30} = \frac{v_B}{\sin 64} = \frac{v_A}{\sin 26}$$

$$v_A = \frac{v_B \cdot \sin 26}{\sin 64} = 9.56 \text{ m.s}^{-1}$$

$$v_{A/B} = \frac{v_B \cdot \sin 30}{\sin 64} = 10.91 \text{ m.s}^{-1}$$

$$v_{A/B} = \omega_{AB} \cdot AB \rightarrow \omega_{AB} = \frac{v_{A/B}}{AB} = \frac{10.9}{0.25} = 43.6 \text{ rad.s}^{-1}$$

$$\vec{v}_G = \vec{v}_B + \vec{v}_{G/B}$$

عبر نقطه G

$$\rightarrow x: v_{Gx} = v_B \cdot \cos 30 + v_{G/B} \cdot \cos 64$$

$$\uparrow y: v_{Gy} = v_B \cdot \sin 30 - v_{G/B} \cdot \sin 64$$

$$v_{G/B} = \omega_{AB} \cdot GB = 43 \times 0.1 = 4.3 \text{ m.s}^{-1}$$

هناك اتجاهين في اتجاه اليمين

$$v_{Gx} = 19.6 \cdot \cos 30 + 4.3 \cdot \cos 64 = 18.85 \text{ m.s}^{-1}$$

$$v_{Gy} = 19.6 \cdot \sin 30 - 4.3 \cdot \sin 64 = 6 \text{ m.s}^{-1}$$

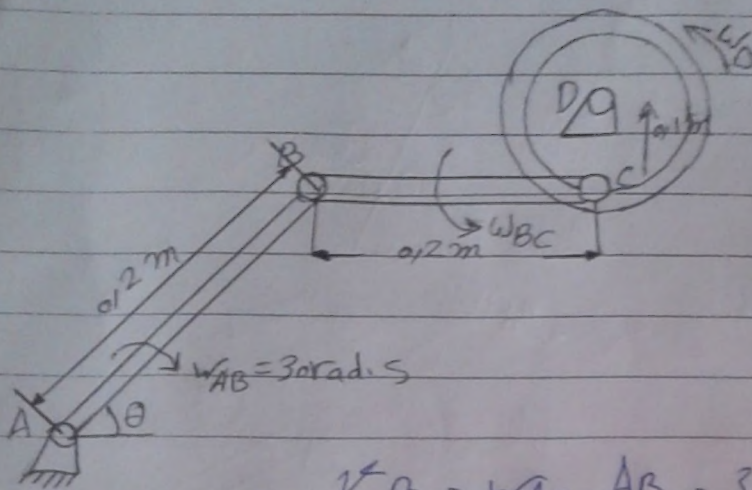
$$v_G = \sqrt{v_{Gx}^2 + v_{Gy}^2} = 19.7 \text{ m.s}^{-1}$$

الاستاذ  
[Signature]



سؤال 2. 239

المعطيات:



$$\omega_{AB} = 3 \text{ rad/s}$$

$$r = 0.1 \text{ m}$$

$$AB = BC = 0.2 \text{ m}$$

$$\theta = 60^\circ$$

$$v_B = \omega_{AB} \cdot AB = 3 \times 0.2 = 0.6 \text{ m/s}$$

$$\vec{v}_C = \vec{v}_B + \vec{v}_{C/B}$$

$$\rightarrow x: v_C = v_B \cos 30^\circ = 0.52 \text{ m/s}$$

$$\omega_D = \frac{v_C}{r} = \frac{0.52}{0.1} = 5.2 \text{ rad/s}$$

$$\uparrow y: 0 = v_B \sin 30^\circ + v_{C/B}$$

$$\Rightarrow v_{C/B} = -v_B \sin 30^\circ \Rightarrow -0.6 \times \sin 30^\circ = -0.3 \text{ m/s}$$

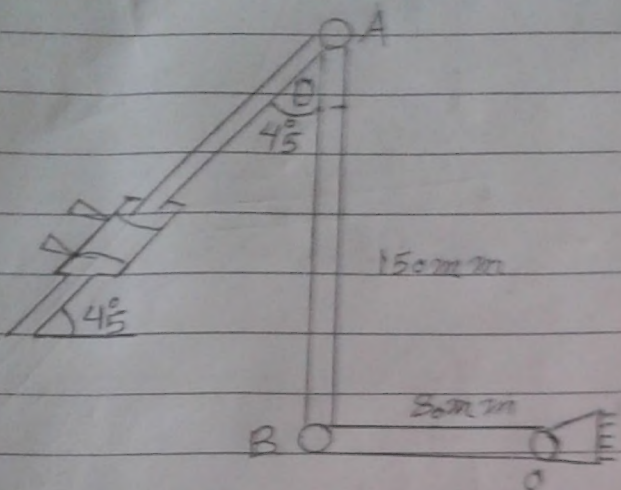
$$\omega_{BC} = \frac{v_{C/B}}{BC} = \frac{-0.3}{0.2} = -1.5 \text{ rad/s}$$





مسألة 3 - 238

المعطي



$$V_A = 80 \text{ mm/s} = \text{const}$$

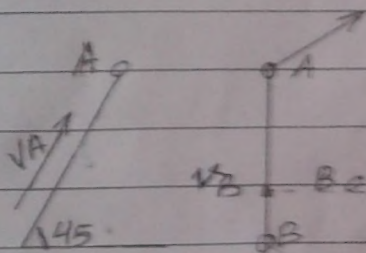
$$\theta = 45^\circ, AB = 150 \text{ mm}$$

$$OB = 80 \text{ mm}$$

$$\vec{V}_B = \vec{V}_A + \vec{V}_{B/A}$$

$$\vec{x}: 0 = V_A \cos 45^\circ - V_{B/A}$$

$$\Rightarrow V_{B/A} = 56.57 \text{ m.m.s}^{-1}$$



$$\uparrow y: V_B = V_A \sin 45^\circ = 56.57 \text{ m.m.s}^{-1}$$

$$\omega_B = \frac{V_B}{OB} = \frac{56.57}{80} = 0.7 \text{ rad.s}^{-1}$$

$$\vec{A}_B = \vec{A}_A + \vec{A}_{B/A}, \quad \omega_A = \text{const} \Rightarrow A_A = 0$$

$$A_B^t + A_B^n = A_{B/A}^t + A_{B/A}^n$$

$$\uparrow \quad \rightarrow \quad \rightarrow \quad \uparrow$$

$$\rightarrow x: A_B^n = A_{B/A}^t = \frac{V_{B/A}^2}{OB} = \frac{(56.57)^2}{80} = 40 \text{ m.m.s}^{-2}$$

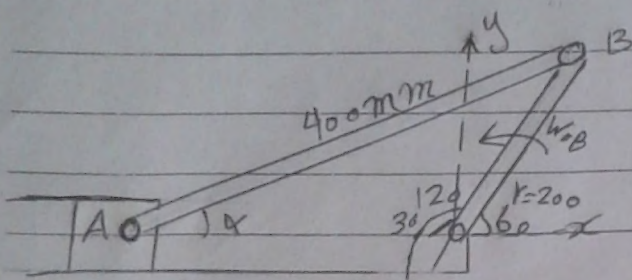
$$\uparrow y: A_{B/A}^n = A_B^t = \frac{V_{B/A}^2}{AB} = \frac{(56.57)^2}{150} = 21.3 \text{ m.m.s}^{-2}$$

$$\Rightarrow |A_B| = \sqrt{(A_B^n)^2 + (A_B^t)^2} = \sqrt{(40)^2 + (21.3)^2} = 45.3 \text{ m.m.s}^{-2}$$



مسألة 4 - 238

المعطيات

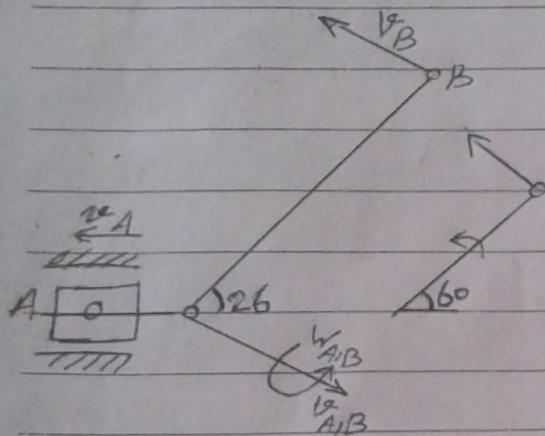


$$\omega_{OB} = 4 \text{ rad.s}^{-1}$$

$$r = 200 \text{ mm} = 0.2 \text{ m}$$

$$l = 400 \text{ mm} = 0.4 \text{ m}$$

$$\theta = 60^\circ, \alpha = 26^\circ$$



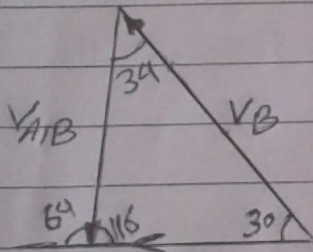
الوحدة B دورانية

$$v_B = \omega_{OB} \cdot OB = 4 \times 0.2 = 0.8 \text{ m.s}^{-1}$$

الوحدة AB متحركة المعطى B و A

$$v_A = v_B + v_{A/B}$$

مثلث السرعة:



$$v_A = v_B = v_{A/B}$$

$$\sin 34 \quad \sin 116 \quad \sin 30$$

$$v_A = \frac{0.8 \times \sin 34}{\sin 116} = 0.15 \text{ m.s}^{-1}$$

$$v_{A/B} = \frac{0.8 \times \sin 30}{\sin 116} = 0.44 \text{ m.s}^{-1}$$

$$\omega_{A/B} = \frac{v_{A/B}}{AB} = \frac{0.44}{0.4} = 1.1 \text{ rad.s}^{-1}$$

كيف أوجدنا الزوايا

$$\phi = 90 - \alpha, \quad \hat{O} = 180 - \theta = 120^\circ$$

$$\Rightarrow \frac{400}{\sin 120} = \frac{200}{\sin \alpha}$$

$$\Rightarrow \sin \alpha = 0.433 \Rightarrow \alpha = 26^\circ$$

$$\Rightarrow \phi = 90 - 26 = 64.34^\circ$$



$$\vec{A}_A = \vec{A}_B + \vec{A}_{A/B}$$

$$A_A^t = A_B^n + A_{A/B}^t + A_{A/B}^n$$

$$\vec{x}: A_A^t = -A_B^n \cos 60 + A_{A/B}^t \cos 64 + A_{A/B}^n \cos 26 \quad \text{①}$$

$$\Rightarrow A_A^t = -2.41 \text{ m.s}^{-2} \quad \text{في الاتجاه المعاكس}$$

$$\vec{y}: 0 = -A_B^n \sin 60 - A_{A/B}^t \sin 64 + A_{A/B}^n \sin 26 \quad \text{②}$$

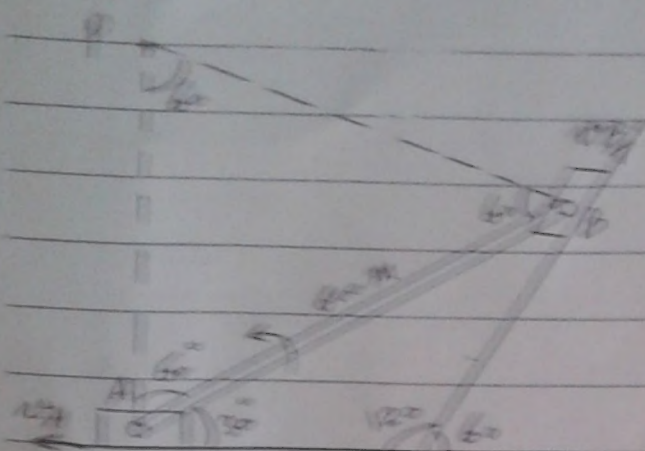
$$\Rightarrow A_{A/B}^t = -2.84 \text{ m.s}^{-2} \quad \text{في الاتجاه المعاكس}$$

$$A_{A/B}^n = \frac{V_{A/B}^2}{R_{AB}} = \frac{(0.44)^2}{0.4} = 0.48 \text{ m.s}^{-2}$$

$$A_B^n = \frac{V_B^2}{R_B} = \frac{(0.8)^2}{0.2} = 3.2 \text{ m.s}^{-2}$$

$$A_A = A_A^t = 2.41 \text{ m.s}^{-2}$$





مسألة 5 ص 239

المعطيات:

$$\omega = 22 \text{ rad.s}^{-1} \quad AB = 60 \text{ cm}$$

طريق المراكز الثلاث

$$\omega_B = \omega_{AB} \cdot PB = 22 \times 60 = 13.2 \text{ m.s}^{-1}$$

$$\omega_A = \omega_{AB} \cdot PA = 22 \times 60 = 13.2 \text{ m.s}^{-1}$$

مناب  $ABP = \omega_{AB} \cdot PB \cdot PA$

$$AB = PA = PB = 60 \quad \frac{\omega_A}{\sin 60} = \frac{PA}{\sin 60} = \frac{PB}{\sin 60}$$

أو عن طريق التماس في نقطة التماس

$$\omega_A = \omega_B$$

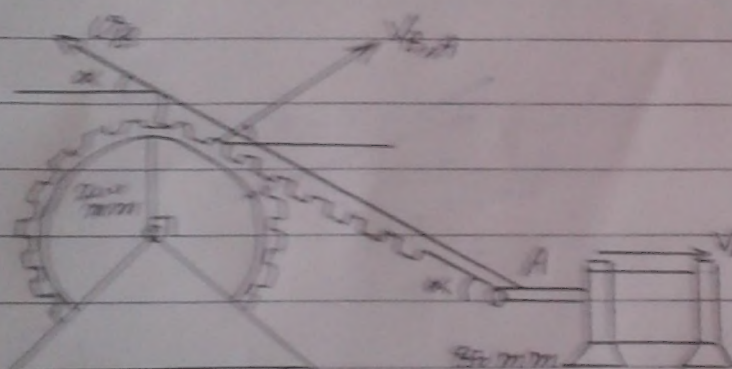
مسألة 6 ص 239

المعطيات:

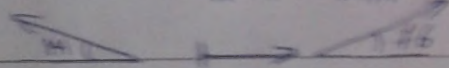
$$\omega_A = 0.3 \text{ m.s}^{-1}$$

$$\alpha = 800 \text{ mm} = 0.8 \text{ m.s}^{-1}$$

$$r = 200 \text{ mm} = 0.2 \text{ m}$$



$$v_B = v_A + v_{B/A}$$



$$\tan \alpha = \frac{0.2}{0.8} \rightarrow \alpha = 14^\circ$$

$$\beta = 90 - \alpha = 76^\circ$$

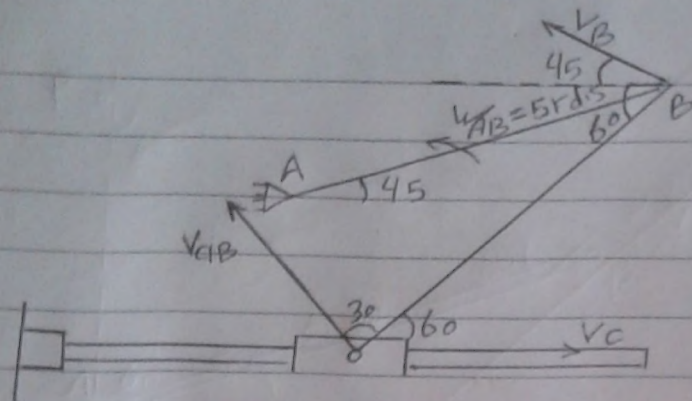
$$\alpha 14^\circ: v_B = -0.3 \cos 14^\circ = -0.29 \text{ m.s}^{-1} \text{ إلى اليسار}$$

$$\omega_B = \frac{v_B}{r} = \frac{-0.29}{0.2} = -1.45 \text{ rad.s}^{-1}$$

$$\omega_{AB} = \frac{-0.29}{0.8} = -0.36 \text{ rad.s}^{-1}$$

$$\beta 76^\circ: \alpha = v_A \sin 14^\circ + \omega_B r \rightarrow v_B = 0.3 \sin 14^\circ - 1.45 \times 0.2 = -0.27 \text{ m.s}^{-1} \rightarrow \omega_{AB} = \frac{v_B}{r}$$





$$\omega = 5 \text{ rad/s}$$

$$AB = 60 \text{ cm}$$

$$BC = 80 \text{ cm}$$

$$\theta = 60^\circ, \phi = 45^\circ$$

الحركة AB دائرية

$$V_B = \omega_{AB} \cdot AB = 5 \times 60 = 300 \text{ cm/s} = 0.3 \text{ m/s}$$

الحركة BC مستقيمة

$$V_C = V_B + V_{C/B}$$

$$\uparrow y: 0 = V_B \sin 45^\circ + V_{C/B} \sin 30^\circ$$

$$V_{C/B} = -\frac{V_B \sin 45^\circ}{\sin 30^\circ} = -424 \text{ m/s}$$

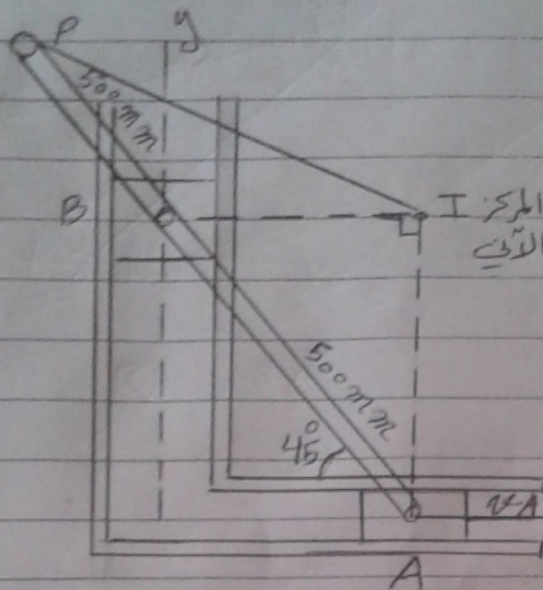
$$\omega_{CB} = \frac{V_{C/B}}{CB} = \frac{424}{80} = 5.3 \text{ rad/s}$$

$$\rightarrow x: V_C = -V_B \cos 45^\circ - V_{C/B} \cos 30^\circ$$

$$V_C = -300 \cos 45^\circ + 424 \cos 30^\circ = 155 \text{ cm/s}$$

$$V_C = 1.55 \text{ m/s}$$





مسألة 9 - 241

المعطيات -

$$\omega = 2 \text{ rad/s}$$

$$\theta = 45^\circ$$

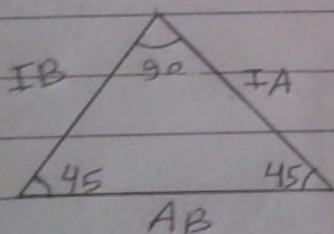
$$PB = AB = 500 \text{ mm} = 0.5 \text{ m}$$

طريقة المركز الآلي

$$v_A = v_B = \omega_{AB} \cdot BI$$

$$v_A = 2 \times 0.3535 = 0.707 \text{ m/s}$$

$$v_P = \omega_{AB} \times IP = 2 \times 0.79 = 1.58 \text{ m/s}$$



س ل ب A I B I

$$IB = AB = IA$$

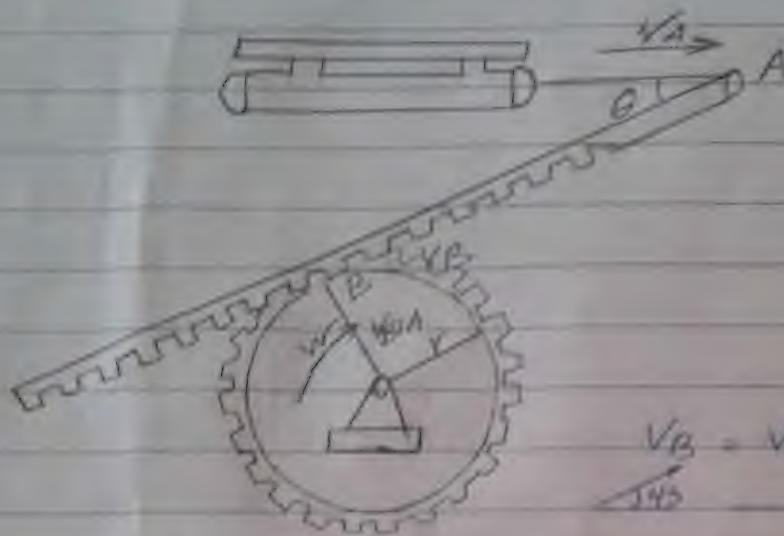
$$\sin 45 \quad \sin 90 \quad \sin 45$$

$$IB = IA = \frac{0.5 \times \sin 45}{\sin 90} = 0.3535$$

$$IP = \sqrt{AP^2 + AI^2 - 2AI \times AP \cos 45} = 0.79$$

$$L \quad 0.124 \quad 0.4999$$





$$v = 15 \text{ cm}$$

$$v_A = 0.5 \text{ m/s}$$

$$\theta = 45^\circ$$

$$v_B = v_A = v_{B/A}$$

$$v_B \cos 45^\circ = 2 \times 4 = v_{A/B} \cos 45^\circ$$

$$v_B \sin 45^\circ = v_{A/B} \sin 45^\circ$$

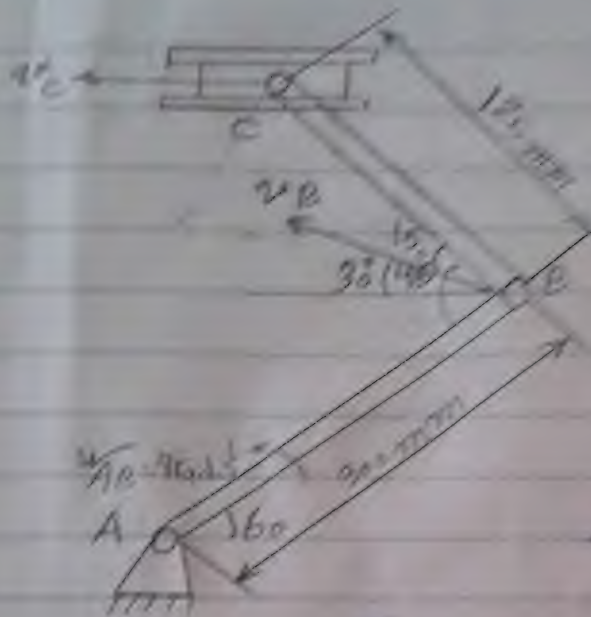
$$v_B = v_{A/B}$$

$$v_B = \frac{v_A}{2 \cos 45^\circ} = \frac{0.5}{\sqrt{2}} \text{ m/s}$$

$$\omega = \frac{v_B}{R} = \frac{1}{2\sqrt{2}} = 2.36 \text{ rad/s}$$



سؤال 11



$$\omega = 4 \text{ rad/s}$$

$$\theta = 60^\circ$$

$$AC = 1250 \text{ mm} = 0.125 \text{ m}$$

$$CB = 125 \text{ mm} = 0.125 \text{ m}$$

$$V_C = V_A = V_B$$

$$V \perp \omega$$

$$V_C = V_A \cos 30^\circ - V_B \cos 45^\circ$$

$$0 = V_A \cos 30^\circ - V_B \cos 45^\circ$$

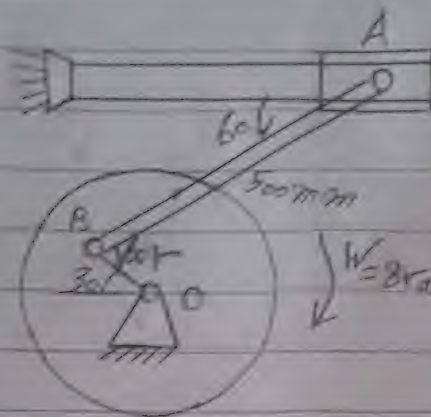
$$0 = V_B \sin 30^\circ - V_A \sin 45^\circ$$

$$V_C = V_B = \frac{1.25 \times 4}{\sin 45^\circ} = 0.85 \text{ m/s}$$

$$V_C = 1.64 \text{ m/s}$$

$$V_B = \omega_{AB} \cdot AB = 4 \times 0.3 = 1.2 \text{ m/s}$$





السرعة 1.2 م/ث

الزاوية 30°

$$\omega = 8 \text{ rad/s}$$

$$\theta = 30^\circ, \phi = 60^\circ$$

$$r_B = 150 \text{ mm} = 0.15 \text{ m}$$

$$r_{AB} = 500 \text{ mm} = 0.5 \text{ m}$$

الوحدة B و A في دائرة

$$v_B = \omega \cdot r_B = 8 \times 0.15 = 1.2 \text{ m/s}$$

الوحدة AB في دائرة

$$\vec{v}_A = \vec{v}_B + \vec{v}_{A/B}$$

$$\rightarrow 160^\circ \quad 160^\circ$$

$$v_A = v_B \cos 60^\circ + v_{A/B} \cos 30^\circ$$

السرعة 1.64 م/ث

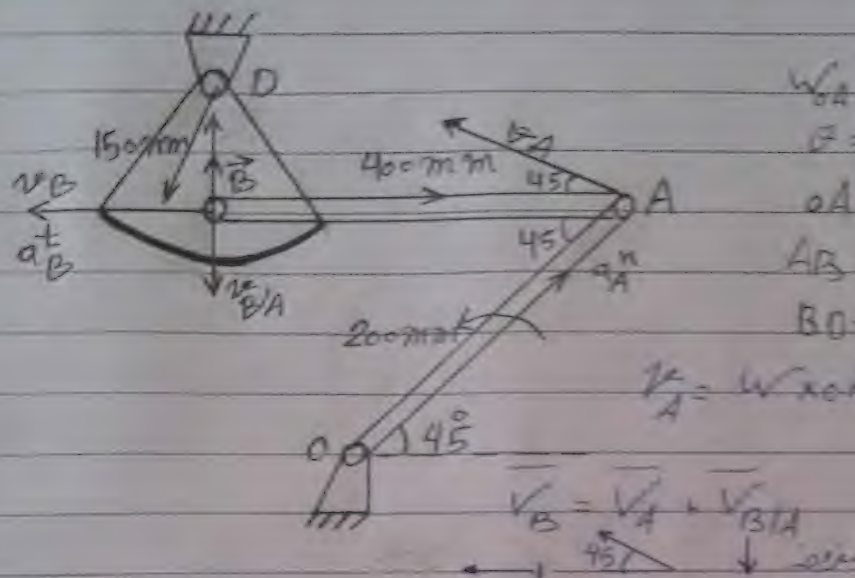
$$v_A = 1.64 \Rightarrow 2.4 \text{ m/s}$$

$$0 = v_B \sin 60^\circ + v_{A/B} \sin 30^\circ$$

السرعة 2.108 م/ث

$$v_{A/B} = \frac{v_B \sin 60^\circ}{\sin 30^\circ} = 2.108 \text{ m/s}$$





$$\omega_A = 4 \text{ rad/s}$$

$$\theta = 45^\circ$$

$$OA = 200 \text{ mm} = 0.2 \text{ m}$$

$$AB = 400 \text{ mm} = 0.4 \text{ m}$$

$$BO = 150 \text{ mm} = 0.15 \text{ m}$$

$$V_A = \omega_A \times OA = 4 \times 0.2 = 0.8 \text{ m/s}$$

$$\vec{V}_B = \vec{V}_A + \vec{V}_{B/A}$$

$$\rightarrow x: \quad V_B = V_A \cos 45^\circ = 0.56$$

$$\uparrow y: \quad 0 = V_A \sin 45^\circ - V_{B/A} =$$

$$V_{B/A} = 0.8 \sin 45^\circ = 0.56 \text{ m/s}$$

$$\omega_{AB} = \frac{V_{B/A}}{AB} = \frac{0.5656}{0.4} = 1.414 \text{ rad/s}$$

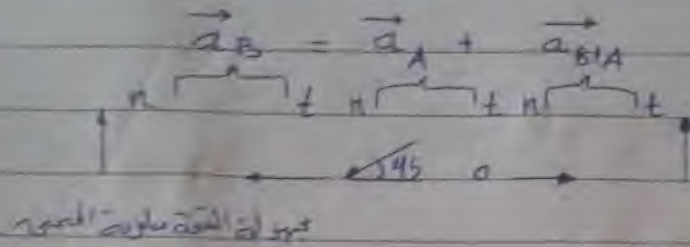
$$\omega_{BD} = \frac{V_B}{BO} = \frac{0.5656}{0.15} = 3.77 \text{ rad/s}$$

السرعة الزاوية للعارضة = 3.77 rad/s



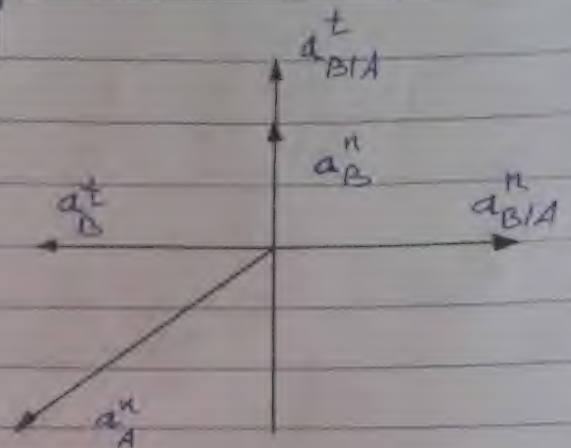
نقطة A تتحرك في حركة دائرية منتظمة

$$a_A^n = \omega_A^2 \cdot A = 16 \times 0.2 = 3.2 \text{ m.s}^{-2}$$



$$a_B^n = \omega_{BD}^2 \cdot BD = (13.77)^2 \times 0.15 = 2.132 \text{ m.s}^{-2}$$

$$a_{B/A}^n = \omega_{AB}^2 \cdot AB = (1.414)^2 \times 0.4 = 0.8 \text{ m.s}^{-2}$$



نقطة B تتحرك في حركة دائرية منتظمة

$$a_B^t = a_A^n \cos 45 - a_{B/A}^n \Rightarrow a_B^t = 3.2 \cos 45 - 0.8 = 1.462 \text{ m.s}^{-2}$$

$$\Rightarrow \sum_{BD} = \frac{a_B^t}{BD} = \frac{1.462}{0.15} = 9.7 \text{ rad.s}^{-2}$$

نقطة A تتحرك في حركة دائرية منتظمة

$$a_B^n = -a_A^n \cos 45 + a_{B/A}^t \Rightarrow 2.132 + 3.2 \times \cos 45$$

$$\Rightarrow a_{B/A}^t = 4.394 \text{ m.s}^{-2}$$

$$\sum_{AB} = \frac{a_{B/A}^t}{AB} = \frac{4.394}{0.4} = 10.98 \text{ rad.s}^{-2}$$







$$A_{PIB}^L = \frac{444 \cos 30 + 39.8 \cos 77.4}{\cos 16.2} = 372.5$$

$$A_P = A_{PIB}^L = 372.5$$

$$A_P = A_{PIB}^L = 156.3$$

من التتابع الطائفي ومن ثم يوضح سيارك التتابع.

$$A_B^n = w_{OB}^2 \times OB = (30 \times 10^3)^2 \times 0.15 = 444 \text{ m}^{-2}$$

أو  $\frac{30^2 \times 10^6}{100} = 444 \text{ m}^{-2}$

$$A_{PIB}^n = w_{BP}^2 \times BP = (16.3)^2 \times 0.15 = 39.8 \text{ m}^{-2}$$

الزاوية الثانية عند  $\theta = 120^\circ$

من العلاقة  $\sin 120 = \sin 4$  أو  $\sin 120 = \sin 4$

$$150 = 50 \Rightarrow 50 \times \sin 120 = 0.28 \Rightarrow x = 16.2$$

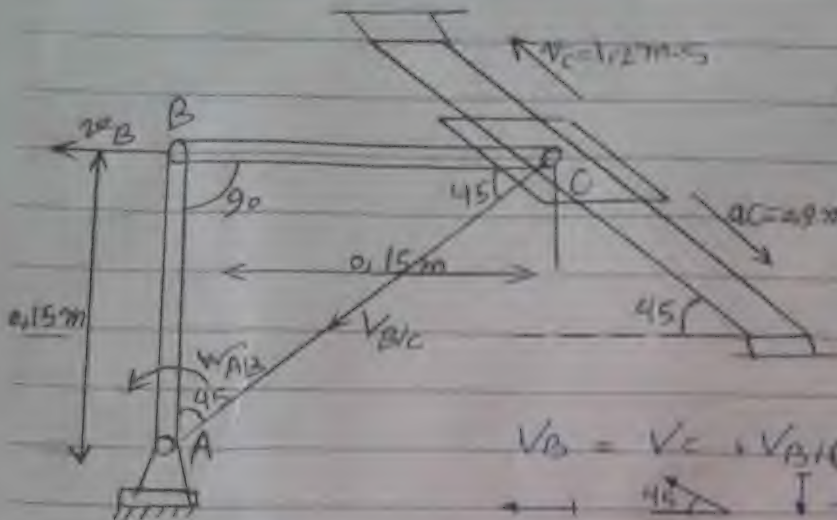
$$\sin 120 = \sin 4 \quad 150$$

من التتابع الطائفي ومن ثم يوضح سيارك التتابع.

الخط



مسألة 244  
المعطيات:



$$v_C = 1.2 \text{ m/s}$$

$$a_C = 0.9 \text{ m/s}^2$$

$$\theta = 90^\circ$$

$$AB = 0.15 \text{ m}$$

$$BC = 0.15 \text{ m}$$

$$v_B = v_C + v_{B/C}$$

$$v_B = v_C \cos 45^\circ + v_{B/C} \sin 45^\circ$$

$$\rightarrow v_B = v_C \cos 45^\circ \Rightarrow v_B = 0.85 \text{ m/s}$$

$$\uparrow 0 = v_C \sin 45^\circ - v_{B/C} \Rightarrow v_{B/C} = 0.85 \text{ m/s}$$

$$\omega_{AB} = \frac{v_B}{AB} \Rightarrow \omega_{AB} = \frac{0.85}{0.15} = 5.66 \text{ rad/s}$$

$$a_B = a_C \cos 45^\circ + a_{B/C} \sin 45^\circ$$

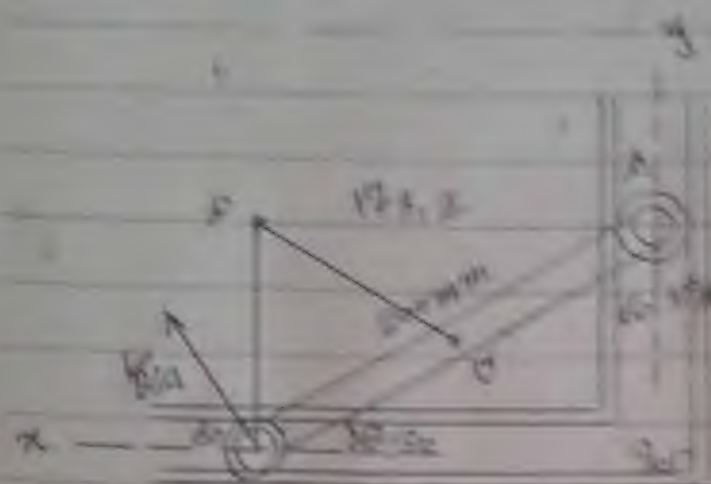
$$\rightarrow a_B^t = a_C^t \cos 45^\circ + a_{B/C}^n \Rightarrow 0.9 \cos 45^\circ + 4.8 = 5.43 \text{ m/s}^2$$

$$\Sigma a_B = \frac{a_B^t}{AB} = \frac{5.43}{0.15} = 36.2 \text{ rad/s}^2, a_{B/C}^n = \frac{(v_{B/C})^2}{BC} = \frac{(0.85)^2}{0.15} = 4.8 \text{ m/s}^2$$

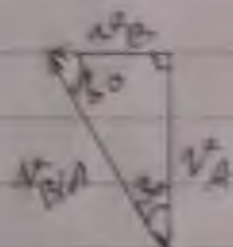
$$a_{B/C}^n = \omega_{AB}^2 \times AB = (5.66)^2 \times 0.15 = 4.8$$

$$\uparrow -a_B^n = -a_C \sin 45^\circ - a_{B/C}^t \Rightarrow a_{B/C}^t = 4.8 - 0.9 \sin 45^\circ = 4.16 \text{ m/s}^2$$





$$\vec{V}_B = \vec{V}_A + \vec{V}_{B/A}$$



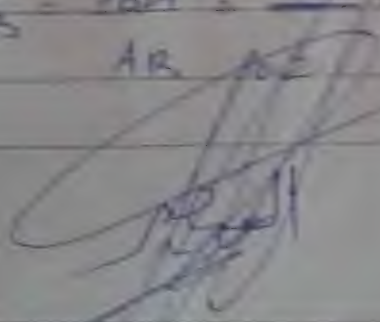
$$\frac{V_A}{\sin 37^\circ} = \frac{V_B}{\sin 53^\circ} = \frac{V_{B/A}}{\sin 90^\circ}$$

$$V_A = V_{B/A} \sin 37^\circ = 200 \sin 37^\circ = 120 \text{ m/s}$$

$$\omega_A = \frac{V_A}{r_A} = \frac{120}{0.6} = 200 \text{ rad/s}$$

$$\frac{V_B}{\sin 53^\circ} = \frac{200 \sin 37^\circ}{\sin 53^\circ} = 160 \text{ m/s}$$

$$\omega_{AB} = \frac{V_B}{r_B} = \frac{160}{1.2} = 133.3 \text{ rad/s}$$





$$V_G = \omega_{AB} \cdot G_P \quad (1)$$

$$G_P = \sqrt{(173,25^2 - 1100^2)} = 141 \text{ mm} \rightarrow 0,141 \text{ m} \quad (1) \text{ هو } G_P$$

$$V_G = 11,5 \times 0,141 = 1,6215 \text{ m.s}^{-1}$$

$$\vec{A}_B = \vec{A}_A + \vec{A}_{B/A}$$

$\wedge^t$        $\wedge^t$        $\wedge^t$

$\rightarrow$        $\rightarrow$        $\rightarrow$

$$\vec{A}_B = \vec{A}_A + \vec{A}_{B/A}$$

$$\vec{A}_B^t = -A_{B/A}^n \cos 30^\circ + A_{B/A}^t \cos 60^\circ$$

$$\vec{A}_B^t =$$

$$0 = A_{B/A}^n \sin 30^\circ + A_{B/A}^t \sin 60^\circ \Rightarrow A_{B/A}^t = -26,45 \times \sin 30^\circ = -15,27$$

sin 60 = 0,866

$$A_{B/A}^n = \omega_{AB}^2 \cdot AB = (11,5)^2 \times 0,2 = 26,45$$

$$\sum_{AB} = \frac{A_{B/A}^t}{AB} = \frac{15,27}{0,2} = 76,35 \text{ rad.s}^{-2}$$

$$\alpha_G = \sum_{AB} \cdot AB = 76,35 \times 0,2 = 15,3 \text{ m.s}^{-2}$$





$$\omega_{BD} = \frac{v_D}{BD} = \frac{1.875}{0.25} = 7.5 \text{ rad/s} \quad \curvearrowright$$

$$\vec{A}_D = \vec{A}_A + \vec{A}_{D/A}$$

$\uparrow$   $\nearrow$   $\nearrow$   
 بفرقة  $\theta$   $37^\circ$   $53.13^\circ$

$$A_D^n = \omega_{BD}^2 \times BD = (7.5)^2 \times 0.25 = 14 \text{ m/s}^2 \quad \uparrow$$

$$A_A^n = \omega_{OA}^2 \times OA = (20)^2 \times 0.125 = 50 \text{ m/s}^2$$

$$A_{D/A}^n = \omega_{AD}^2 \times AD = (12.5)^2 \times 0.25 = 39 \text{ m/s}^2 \quad \nearrow 37^\circ$$

$$A_D^n = A_{D/A}^n \sin 37^\circ + A_{D/A}^t \sin 53.13^\circ$$

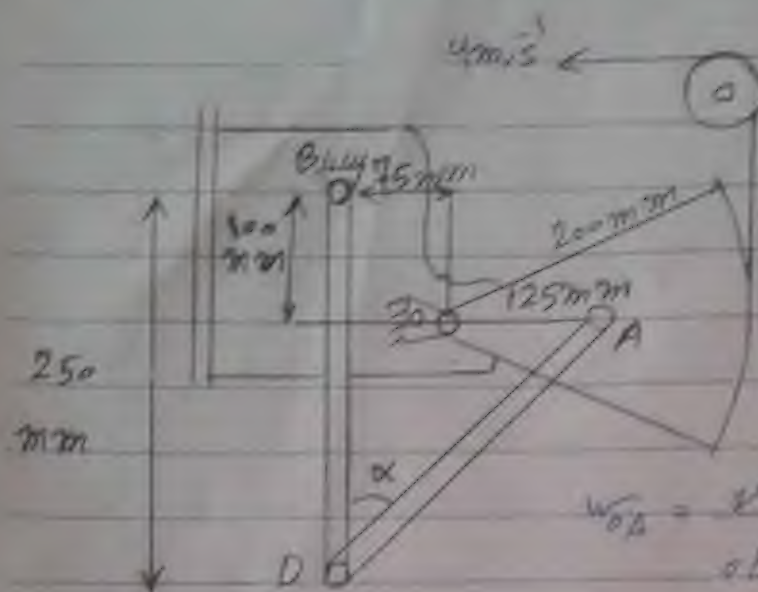
$$A_{D/A}^t = \frac{A_D^n - A_{D/A}^n \sin 37^\circ}{\sin 53.13^\circ} = \frac{14 - 39 \sin 37^\circ}{\sin 53.13^\circ} = 11.8 \text{ m/s}^2$$

$$\sum_{AD} \tau_{AD} = A_{D/A}^t \times AD = 11.8 \times 0.25 = 47.2 \text{ rad/s}^2 \quad \curvearrowright$$

$$\sum \tau_i A_D^t = -A_A^n + A_{D/A}^n \cos 37^\circ - A_{D/A}^t \cos 53.13^\circ$$

$$= -50 + 39 \cos 37^\circ + 11.8 \cos 53.13^\circ = -11.7 \text{ m/s}^2$$

$$\sum \tau_{BD} = A_D^t \times BD = 11.7 \times 0.25 = 46.8 \quad \curvearrowright$$



$$\omega_F = \omega_E = 4 \text{ rad/s}$$

$$r_A = 125 \text{ mm} \rightarrow 0.125 \text{ m}$$

$$r_{AE} = 200 \text{ mm} \rightarrow 0.2 \text{ m}$$

$$r_B = 250 \text{ mm} \rightarrow 0.25 \text{ m}$$

$$r_B = 75 \text{ mm} \rightarrow 0.075 \text{ m}$$

$$\omega_{OA} = \frac{v_E}{r_{AE}} = \frac{4}{0.2} = 20 \text{ rad/s}$$

$$v_A = \omega_{OA} \times r_A = 20 \times 0.125 = 2.5 \text{ m/s}$$

$$\tan^{-1} x = \frac{200}{150} = 53.13$$

في المثلث القائم AD

$$AD^2 = OD^2 + BA^2 = 250 \text{ mm}$$

الوحدة PAD كجسم متين والمعدن هو

$$\vec{v}_D = \vec{v}_A + \vec{v}_{D/A}$$

معرفة

في

$$y \uparrow: 0 = v_A - v_{D/A} \sin 53.13 \rightarrow v_{D/A} = v_A - 2.5 = 3.125 \text{ m/s}$$

$$\sin 53.13 \sin 53.13$$

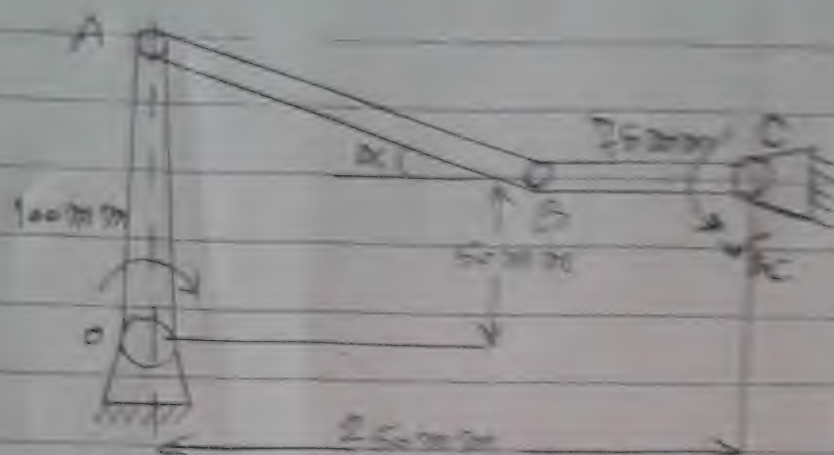
$$\omega_{AD} = \frac{v_{D/A}}{r_{AD}} = \frac{3.125}{0.25} = 12.5 \text{ rad/s}$$

$$AD = 0.25$$

في

$$x \leftarrow: v_D = v_A \cos 53.13 \rightarrow v_D = 1.875 \text{ m/s}$$





سأكتب في 15 دقيقة

المعطيات:

$$V_B = 20 \text{ cm.s}^{-1}$$

$$AB = 100 \text{ cm}$$

$$BC = 25 \text{ cm}$$

$$CD = 25 \text{ cm}$$

$$DE = 25 \text{ cm}$$

$$V_B = V_{CB}, \quad CB = 2 \times 3.5 = 15 \text{ cm.s}^{-1} \downarrow$$

$$\vec{V}_A = \vec{V}_B + \vec{V}_{A/B}$$



في الزاوية الأولى

$$\tan \alpha' = \left( \frac{50}{200} \right) \Rightarrow \alpha' = 14^\circ$$

$$AB = \sqrt{20^2 + 5^2} = \sqrt{425} = 20.61 \text{ cm}$$

في الزاوية الثانية

$$\omega = V_B + V_{A/B} \cos \alpha$$

$$V_{A/B} = \frac{V_B}{\cos \alpha} = \frac{15}{\cos 14} = 15.45 \text{ cm.s}^{-1}$$

$$\omega_{A/B} = \frac{V_{A/B}}{AB} = \frac{15.45}{20.6} = 0.75$$

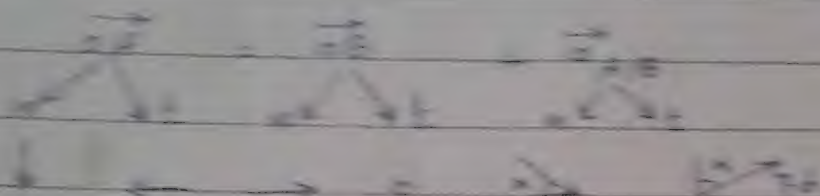
في الزاوية الثالثة

$$V_A = \omega_{A/B} \times AB \sin \alpha$$

$$V_A = 3.74 \text{ cm.s}^{-1}$$

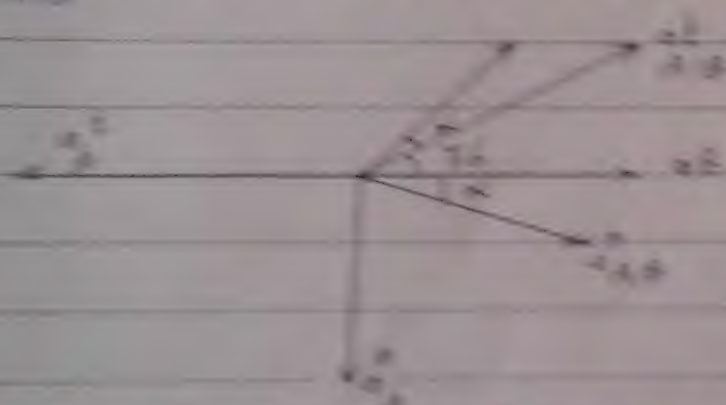
$$\omega_{AB} = \frac{v_B}{r_B} = \frac{3.75}{1.5} = 2.5 \text{ rad s}^{-1}$$

$$a_B = a_C + \omega_{AB}^2 r_{CB} = 2.5^2 \times 2 = 12.5 \text{ cm s}^{-2}$$



$$a_B^x = \frac{v_B^2}{r_B} = \frac{3.75^2}{1.5} = 9.375 \text{ cm s}^{-2}$$

$$a_{AB}^x = \omega_{AB}^2 r_{AB} = 2.5^2 \times 2 = 12.5 \text{ cm s}^{-2}$$



$$a_B^x = a_{AB}^x \cos \alpha = a_{AB}^x \sin \alpha$$

Equation 1

$$a_{AB}^x = 12.5 \text{ cm s}^{-2}$$

Equation 2

$$a_B^y = a_{AB}^y \cos \alpha + a_{AB}^x \sin \alpha$$







$$a_A^t = -11.58 \text{ cm s}^{-2}$$

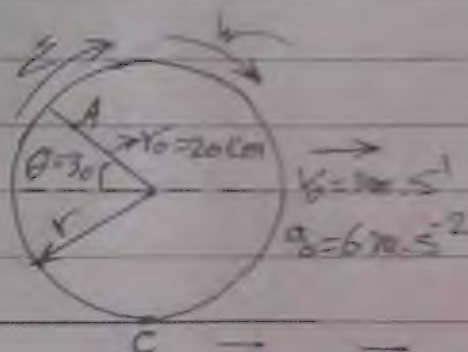
المطلوب =  $a_A^t$

$$A_A^t = \sum \omega A \times A \Rightarrow \sum \omega A = \frac{A_A^t}{A} = \frac{-11.58}{10} = -1.158 \text{ rad s}^{-2}$$

$$A_{A/B} = \sum A_B \times A_B \Rightarrow \sum A_B = \frac{A_{A/B}}{A_B} = \frac{-1.94}{20.6} = -0.094 \text{ rad s}^{-2}$$

$$-0.094 \times 19 = -1.786$$

المطلوب =  $a_A^t$



$$R_0 = 20 \text{ cm} = 0.2 \text{ m}$$

$$v_0 = 3 \text{ m/s}$$

$$a_0 = 6 \text{ m/s}^2$$

$$R_0 = 20 \text{ cm}$$

$$\vec{V}_A = \vec{V}_0 + \vec{V}_{A/0}$$

$$\vec{V}_A = \vec{V}_0 + \vec{V}_{A/0}$$

$$\omega = \frac{v_0}{R_0} = \frac{3}{0.2} = 15 \text{ rad/s}$$

$$R_0 = 0.2$$

$$V_{A/0} = \omega \times A = 15 \times 0.2 = 3 \text{ m/s}$$

$$\vec{V}_A = \vec{V}_0 + \vec{V}_{A/0} \cos 60 = 3 + 3 \cos 60 = 4.5 \text{ m/s}$$

$$\vec{V}_A = 0 + V_{A/0} \sin 60 = \sqrt{3} = 1.7 \text{ m/s}$$

$$V_A = \sqrt{V_{Ax}^2 + V_{Ay}^2} = \sqrt{4^2 + 1.7^2} = 4.36 \text{ m/s}$$

$$A_A = A_0 + A_{A/0}$$

$$A_A = A_0 + A_{A/0}$$

$$A_0 = \frac{a_0}{R_0} = \frac{6}{0.2} = 30 \text{ rad/s}^2$$

$$R_0 = 0.2$$



$$A_{A/O}^t = 2r \cdot \omega A = 20 \times 0.2 = 4 \text{ m}^2/\text{s}$$

$$A_{A/O}^n = \frac{V A_{A/O}^2}{\omega A} = \frac{4}{0.2} = 20 \text{ m}^2/\text{s}$$

$$\vec{x} = A_{A/H} = A_O + A_{A/O}^n \cos 60^\circ + A_{A/O}^t \cos 30^\circ \quad \text{m}^2/\text{s}$$

$$A_{A/H} = 6 + 20 \cos 60^\circ + 4 \cos 30^\circ = 19.4 \text{ m}^2/\text{s}$$

$$\uparrow y = A_{A/y} = A_{A/O}^n \sin 60^\circ - A_{A/O}^t \sin 30^\circ$$

$$A_{A/y} = 20 \sin 60^\circ - 4 \sin 30^\circ = 15.3 \text{ m}^2/\text{s}$$

$$A_A = \sqrt{A_{A/H}^2 + A_{A/y}^2} = \sqrt{19.4^2 + 15.3^2} = 25 \text{ m}^2/\text{s}$$

$$A_C = A_O + A_{C/O}$$

$$\vec{x} \quad \vec{r} \quad \vec{r} \quad \vec{r}$$

$$O \rightarrow \uparrow \rightarrow \vec{r}$$

$$A_{C/O}^t = \omega_r^2 \cdot r = (10)^2 \times 0.3 = 30 \text{ m}^2/\text{s}$$

$$A_{C/O}^n = 2r \cdot \omega = 20 \times 0.3 = 6 \text{ m}^2/\text{s}$$

$$\vec{x}: A_{C/x} = A_O + A_{C/O}^n = 6 + 6 = 12 \text{ m}^2/\text{s}$$

$$\uparrow y: A_{C/y} = A_{C/O}^t = 30 \text{ m}^2/\text{s}$$

$$A_C = \sqrt{A_{C/x}^2 + A_{C/y}^2} = \sqrt{12^2 + 30^2} = 32.3 \text{ m}^2/\text{s}$$

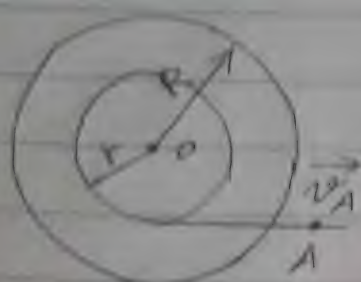




046, 21, 20, 20, 20

046, 21, 20, 20, 20

$$R = 0.6 \text{ m}, \quad r = 0.4 \text{ m}, \quad \omega = 2 \text{ rad/s}$$



$$\omega = \frac{v_A}{r} = \frac{1.2}{0.4} = 3 \text{ rad/s}$$

$$v_D = \omega \times R = 3 \times 0.6 = 1.8 \text{ m/s}$$

047, 21, 20, 20, 20

047, 21, 20, 20, 20



$$\text{const. } \omega = 1.5 \text{ rad/s}, \quad R = 30 \text{ cm}$$

المركبة تتحرك في اتجاه اليمين بسرعة ثابتة  $\omega = 1.5 \text{ rad/s}$   
 في لحظة معينة تكون الزاوية بين نصف القطر والخط  $CD$  هي  $30^\circ$

$$v_E = 0 \text{ m/s}$$

$$\omega = \frac{v_D}{R} = \frac{1.5}{0.3} = 5 \text{ rad/s}$$

$$R = 0.3$$

$$v_B = \omega \times 2R = 5 \times 2 \times 0.3 = 3 \text{ m/s}$$

$$v_E = \omega \times r \sqrt{2} = 5 \times 0.15 \sqrt{2} = 2.12 \text{ m/s}$$

$$v_D = \omega \cdot DC = 2.9 \text{ m/s}$$

$$DC = \omega \cdot r = 2R \cos 15 = 5 \times 2 \times 0.3 \cos 15 = 2.9 \text{ m/s}$$



$$\vec{A}_B = \vec{A}_O + \vec{A}_{B/O}$$

$\downarrow$      $\nwarrow$      $\nearrow$      $\downarrow$   
 $0$      $\omega$      $r$      $0$

↑ y:  $A_B = A_{B/O}^n = \omega^2 r = 50^2 \times 0.3 = 750 \text{ m/s}^2$

$$\vec{A}_C = \vec{A}_O + \vec{A}_{C/O}$$

$\downarrow$      $\nwarrow$      $\nearrow$      $\downarrow$   
 $0$      $\omega$      $r$      $0$

↑ y:  $A_C = A_{C/O}^n = \omega^2 r = 50^2 \times 0.3 = 750 \text{ m/s}^2$

$$\vec{A}_D = \vec{A}_O + \vec{A}_{D/O}$$

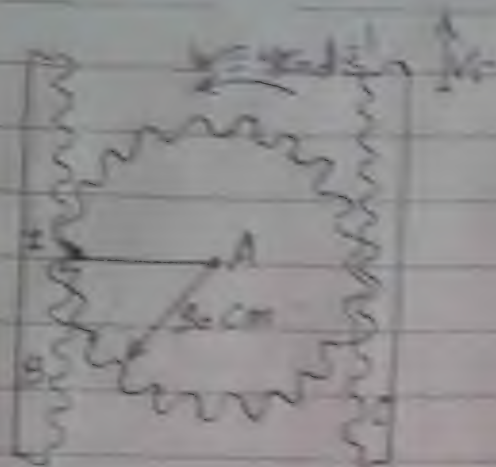
$\downarrow$      $\nwarrow$      $\nearrow$      $\downarrow$   
 $0$      $\omega$      $r$      $0$

$60^\circ \rightarrow \Sigma r = r$

$$A_D = A_{D/O}^n = \omega^2 r \sin(60^\circ) = 650 \text{ m/s}^2$$

*[Handwritten signature]*





مسألة 25 - 45

المطلوب

$$R = 3 \text{ cm} \quad \omega = 4 \text{ rad/s}$$

$$v_A = \omega \times I_A = \omega \times R$$

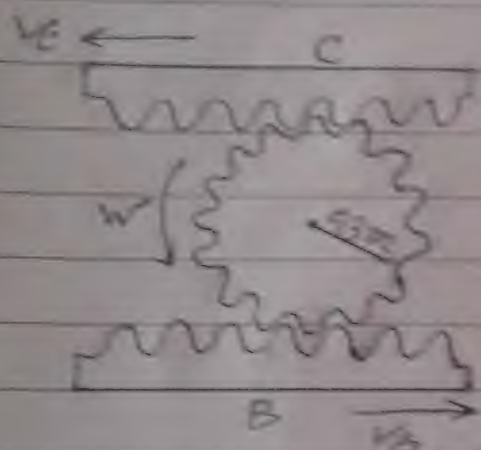
$$= 4 \times 3 = 12 \text{ m/s}$$

$$v_B = \omega \times I_B = \omega \times 2R$$

$$= 4 \times 6 = 24 \text{ m/s}$$

مسألة 25 - 40

المطلوب



$$v_A = 3 \text{ m/s}$$

$$v_B = 4 \text{ m/s} \quad v = 0.3 \text{ m/s}$$

قاعدة التماس في التماس

$$\frac{v_C}{I_C} = \frac{v_B}{I_B} = \omega_r \Rightarrow \frac{v_C}{I_C} = \frac{v_B}{I_B}$$

نفس الشيء في التماس الثاني

$$\frac{v_C + v_B}{I_C + I_B} = \frac{4 + 8}{3 + 8} \Rightarrow I_B = 0.4$$

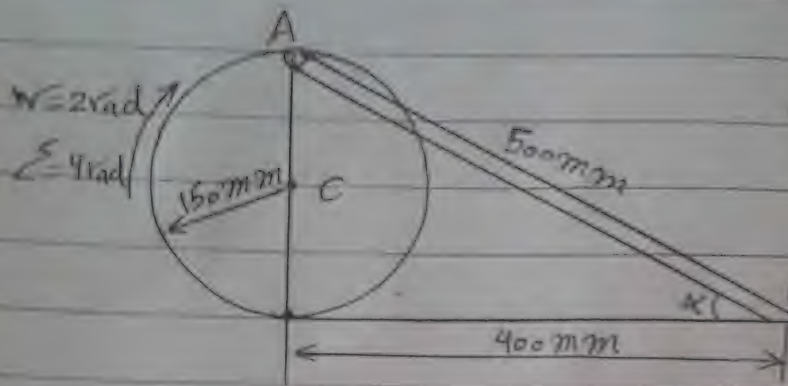
$$\Rightarrow I_C = 0.2 \Rightarrow I = 0.1$$

$$\Rightarrow \omega_r = \frac{v_C}{I_C} = \frac{v_B}{I_B} = \frac{4}{0.2} = \frac{8}{0.4} = 20 \text{ rad/s}$$

$$I_C \quad I_B \quad 0.2 \quad 0.4$$

$$v_A = \omega_r \times R = 20 \times 0.1 = 2 \text{ m/s}$$

في حالة التماس بين واحدة من البكرات المتكافئة أو المتكافئة مع البكرات



$$r = 150 \text{ mm} \rightarrow 0.15 \text{ m}$$

$$\omega = 2 \text{ rad/s}, \epsilon = 4 \text{ rad/s}^2$$

$$\tan^{-1} = \left( \frac{300}{400} \right) = 37^\circ$$

$$v_C = \omega \times r = 2 \times 0.15 = 0.3 \text{ m/s}$$

$$v_A = \omega \times 2r = 2 \times 0.3 = 0.6 \text{ m/s}$$

المركبة الزاوية AB هي الزاوية الزاوية

$$\vec{v}_B = \vec{v}_A + \vec{v}_{B/A}$$

$$\rightarrow \rightarrow \rightarrow 53^\circ$$

$$v_B = v_A = 0$$

المركبة الزاوية AB هي الزاوية الزاوية

$$\omega_{AB} = 0, v_{B/A} = 0$$

$$A_A = A_C + A_{A/C}$$

$$\nearrow 0.3 \text{ m/s}^2 \quad \downarrow 1.2 \text{ m/s}^2$$

$$A_{Ax} = A_C^t + A_{A/C}^t = \epsilon \cdot r + \epsilon \cdot r = 1.2 \text{ m/s}^2$$

$$A_{Ay} = A_{A/C}^n = \omega^2 \cdot r = 0.6 \text{ m/s}^2$$

$$A_A = \sqrt{A_{Ax}^2 + A_{Ay}^2} = \sqrt{1.2^2 + 0.6^2} = 1.34 \text{ m/s}^2$$

$$\vec{A}_B = \vec{A}_A + \vec{A}_{B/A}$$

$$\nearrow 0.3 \text{ m/s}^2 \quad \downarrow 1.2 \text{ m/s}^2 \quad \rightarrow 0$$





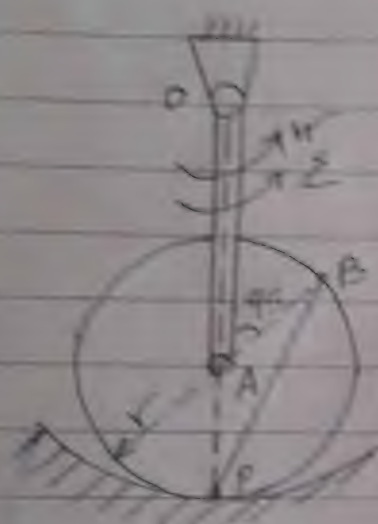
$$a = A_{Ay} + A_{B/A} \sin 53 \quad \uparrow y \text{ direction}$$

$$A_{Ay} = \frac{A_y}{\sin 53} = \frac{0.6}{\sin 53} = 0.75 \text{ m.s}^{-2}$$

$$A_B = A_{Ay} + A_{B/A} \cos 53 = 1.2 - 0.75 \cos 53$$

$$= 0.74 \text{ m.s}^{-2}$$

$$\Sigma_{AB} = \frac{A_B}{AB} = \frac{0.74}{0.5} = 1.5 \text{ rad.s}^{-2}$$



$$\omega = 3 \text{ rad.s}^{-1}, \epsilon = 2 \text{ rad.s}^{-2}$$

$$OA = 30 \text{ cm}, r = 15 \text{ cm}$$

$$v_A = \omega_{OA} \times OA = 3 \times 0.3 = 0.9 \text{ m.s}^{-1}$$

$$A_A^N = \omega_{OA}^2 \times OA = 9 \times 0.3 = 2.7 \text{ m.s}^{-2}$$

$$A_A^t = \epsilon \times OA = 2 \times 0.3 = 0.6 \text{ m.s}^{-2}$$

$$A_A = \sqrt{A_A^N^2 + A_A^t^2} = \sqrt{2.7^2 + 0.6^2} = 2.77 \text{ m.s}^{-2}$$

$$v_P = 0$$

$$\omega_r = \frac{v_P}{r} = \frac{0}{0.15} = 0 \text{ rad.s}^{-1}$$

$$\epsilon_r = \frac{A_A^t}{r} = \frac{0.6}{0.15} = 4 \text{ rad.s}^{-2}$$



$$\vec{V}_B = \vec{V}_A + \vec{V}_{B/A}$$

↑ 45°

$$\omega_r \times r = 6 \times 0.15 = 0.9 \text{ m.s}^{-1}$$

$$\therefore V_{B/A} = \omega_{B/A} \cos 45 = 0.9 \cos 45 = 0.636$$

$$\therefore V_{B_y} = V_A - V_{B/A} \sin 45 = 0.9 + 0.9 \sin 45 = 1.536$$

$$V_B = \sqrt{V_{B_x}^2 + V_{B_y}^2} = \sqrt{(0.636)^2 + (1.536)^2} = 1.67 \text{ m.s}^{-1}$$

السرعة الناتجة هي 1.67 م.س<sup>-1</sup>

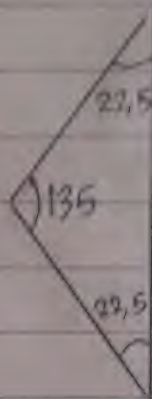
الزاوية هي 22.5°

$$90 + 45 = 135 \rightarrow 180 - 135 = 45$$

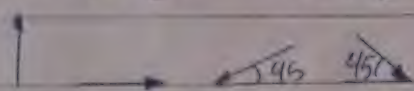
$$\frac{45}{2} = 22.5$$

$$V_B = \omega_r \times 2r \cos(22.5)$$

$$= 6 \times 2 \times 0.15 \cos(22.5) = 1.67 \text{ m.s}^{-1}$$



$$\vec{A}_B = \vec{A}_A + \vec{A}_{B/A}$$



$$A_{B/A} = \omega_r^2 \times AB = 36 \times 0.15 = 5.4, \quad A_{B/A}^t = \epsilon_r \times AB = 4 \times 0.15 = 0.6 \text{ m.s}^{-2}$$

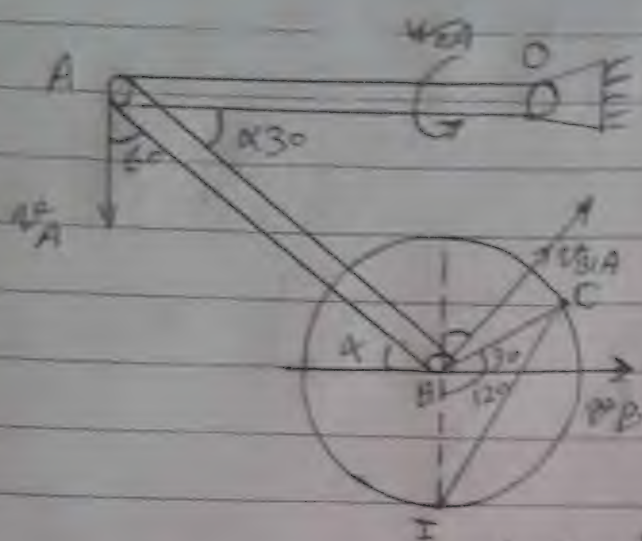
$$\therefore A_{B_x} = A_A^t - A_{B/A}^n \cos 45 + A_{B/A}^t \cos 45 = 0.6 - 5.4 \cos 45 + 0.6 \cos 45 = -2.8$$

$$\therefore A_{B_y} = A_A^n - A_{B/A}^n \sin 45 - A_{B/A}^t \sin 45 =$$

$$= 2.7 - 5.4 \sin 45 - 0.6 \sin 45 = -1.54$$

$$A_B = \sqrt{A_{B_x}^2 + A_{B_y}^2} = \sqrt{(2.8)^2 + (1.54)^2} = 3.2 \text{ m.s}^{-2}$$





250 or 27

$$r_A = 15 \text{ cm}, AB = 60 \text{ cm}$$

$$r = 15 \text{ cm}, \alpha = 30^\circ$$

$$\omega_A = 2 \text{ rad/s}$$

$$v_A = \omega_A \times r_A$$

$$= 2 \times 15 = 30 \text{ cm/s}$$

A is the center of rotation, AB is the radius

$$v_B = v_A + v_{B/A}$$

$$v_B = v_A + v_{B/A}$$

$$v_B = v_A + v_{B/A}$$

$$0 = -v_A + v_{B/A} \sin 60 = v_{B/A} = \frac{v_A}{\sin 60} = \frac{30}{\sin 60} = 34.6 \text{ cm/s}$$

$$v_B = v_A + v_{B/A}$$

$$v_B = v_A + v_{B/A} \cos 60 = 34.6 \cos 60 = 17.3 \text{ cm/s}$$

$$\omega_B = \frac{v_B}{r_B} = \frac{17.3}{15} = 1.15 \text{ rad/s}$$

$$PB = 15$$

$$\omega_{AB} = \frac{v_{B/A}}{AB} = \frac{34.6}{60} = 0.57 \text{ rad/s}$$

$$AB = 60$$

$$v_C = \omega_{AB} \times IC = 1.15 \times 26 = 30 \text{ cm/s}$$

$$IC = \sqrt{r^2 + r^2 - 2rr \cos 120} = \sqrt{15^2 + 15^2 - 2 \times 15 \times 15 \cos 120} = 26 \text{ cm}$$

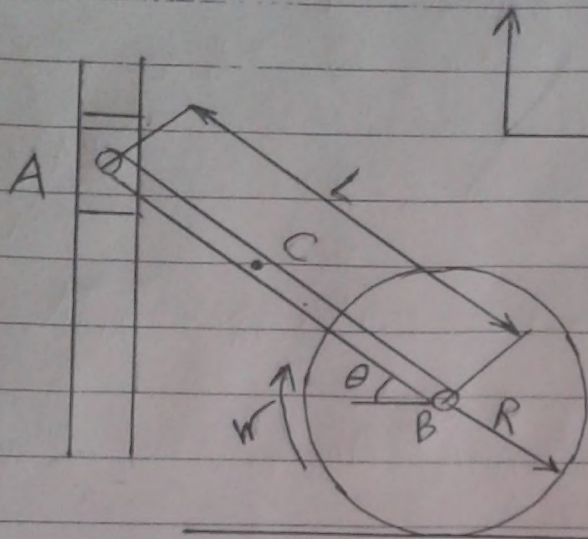








مسألة 28 - 250



$$\omega_r = 2 \text{ rad.s}^{-1}$$

$$\epsilon_r = 5 \text{ rad.s}^{-2}$$

$$A_C = B_C$$

$$R = 20 \text{ cm}, L = 60$$

$$\theta = 60$$

$$v_B = \omega_r \times R$$

$$= 2 \times 20 = 40 \text{ cm.s}^{-1}$$

$$a_B^t = a_B = \epsilon_r \times R$$

$$= 5 \times 20 = 100 \text{ cm.s}^{-2}$$

$$v_A = v_B + v_{A/B}$$

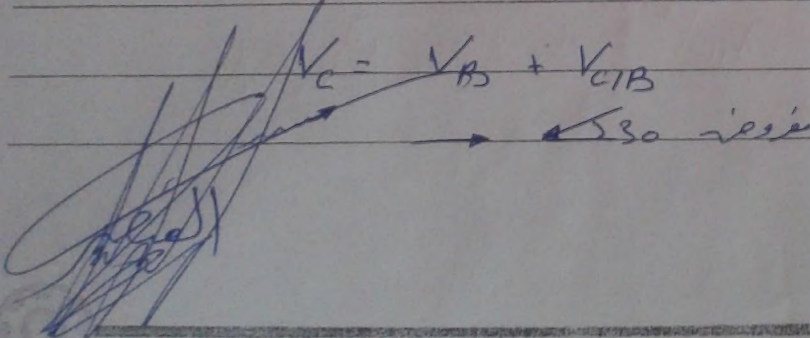
مفردة 30

$$\rightarrow \Sigma: 0 = v_B - v_{A/B} \cos 30 \Rightarrow v_{A/B} = \frac{v_B}{\cos 30} = 46.18 \text{ cm.s}^{-1}$$

$$\uparrow \Sigma: -v_A = 0 - v_{A/B} \sin 30 \Rightarrow v_A = v_{A/B} \sin 30 = 23 \text{ cm.s}^{-1}$$

(-)

$$\omega_{AB} = \frac{v_{A/B}}{AB} = \frac{46.18}{60} = 0.77 \text{ rad.s}^{-1}$$





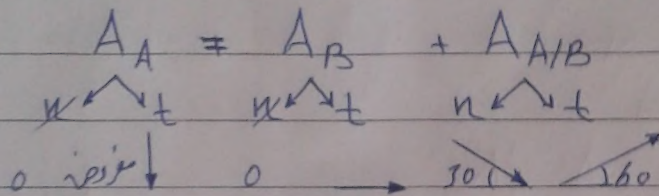


$$V_{C/B} = \omega_{AB} \cdot CB = 0.77 \times 30 = 23.1 \text{ cm.s}^{-1}$$

$$\vec{n}: V_{Cn} = V_B - V_{C/B} \cos 30 = 40 - 23.1 \cos 30 = 19.9 \text{ cm.s}^{-1}$$

$$\uparrow y: V_{Cy} = -V_{C/B} \sin 30 = -11.55 \text{ cm.s}^{-1}$$

$$V_C = \sqrt{V_{Cn}^2 + V_{Cy}^2} = \sqrt{19.9^2 + 11.55^2} = 23.01 \text{ cm.s}^{-1}$$



حركة انتقالية (مستقيمة) حركة انتقالية

$$A_{A/B}^n = \omega_{AB}^2 \times AB = (0.77)^2 \times 60 = 35.5 \text{ cm.s}^{-2}$$

$$A_B = A_B^t = \varepsilon \times R = 5 \times 20 = 100 \text{ cm.s}^{-2}$$

$$\vec{n}: 0 = A_B^t + A_{A/B}^n \cos 30 + A_{A/B}^t \cos 60$$

$$A_{A/B}^t = -A_B^t - A_{A/B}^n \cos 30 = -100 - 35.5 \cos 30 = -261.4$$

على الزاوية العزوم  $\cos 60$

$$\varepsilon_{AB} = \frac{A_{A/B}^t}{AB} = \frac{-261.4}{60} = -4.35 \text{ rad.s}^{-2}$$

$$\uparrow y: -A_A = -A_{A/B}^n \sin 30 + A_{A/B}^t \sin 60$$

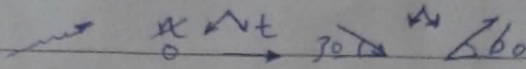
$$A_A = 35.5 \sin 30 + 261 \sin 60 = 243.7$$

*[Handwritten signature]*





$$A_c = A_B + A_{c/B}$$



$$A_{c/B}^n = \omega_{AB}^2 \cdot CB = (0,773)^2 \times 30 = 17,7 \text{ cm.s}^{-2}$$

$$A_{c/B}^t = \varepsilon_{AB} \times CB = 4,35 \times 30 = 130,5 \text{ cm.s}^{-2}$$

$$\begin{aligned} \vec{A}_c &= A_B + A_{c/B}^n \cos 30 + A_{c/B}^t \cos 60 \\ &= 100 + 17,7 \cos 30 + 130,5 \cos 60 = 180,5 \text{ cm.s}^{-2} \end{aligned}$$

*[Handwritten signature]*